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A NEW TELEPHONE SET

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The article presents the basic data on the circuit, characteristics, and design modelling of a new telephone set which is being developed in accordance with technical demands of the Ministry of Communications USSR.

In 1953 and 1954 a discussion was presented in the pages of the magazine Vestnik Svyazi about the requirements a modern telephone set must meet. In the course of this discussion the need was made apparent for substantial improvement of models being produced. The discussion was not without results and the task of developing a new telephone set was assigned to industry.

The development work is being handled by the design department of the VEF plant jointly with the Scientific Research Institute of the Ministry of the Radio Engineering Industry. The first stage of it which is at present completed was conducted on the basis of technical requirements prepared by the Ministry of Communications USSR.

The new telephone set is designed for connection in both automatic stations of various systems (decade step-by step ATS, ATS of machine system, ATS VRS) and manual service telephone stations. It has, in comparison to existing sets, an expanded range of effectively reproducible frequencies (300 to 3,500 cycles). Applied in the set are carbon microphone and electromagnetic telephone caps that possess heightened sensitivity and provide improved quality transmission and speech reproduction. Thus, if the general attenuation of the line and station gear is within the limits of up to 4 nep, the syllable articulation of the set exceeds 55%.

The model of the general circuit of the new telephone set, developed in accordance with the requirements of the Ministry of Communications USSR, is shown in Figure 1. The talking line of the set has a contralocal connection of the compensating type with a 4-element balance circuit. With the object of reducing interference to radio reception, created during operation of the telephone set, the linear winding of the transformer Tr is divided into 2 parts, used in the capacity of choke coils of a high frequency filter, between which an impulse contact number dial is connected. For lowering the voltage of the source of the interference, a spark killer circuit is used, which consists of a resistance of 200 ohms and a capacitor of 0.25 microfarad capacity. The remnant voltage of interference is reduced by a capacitor of 0.05 microfarad capacity, which is connected in parallel with the linear wires.

Depending on the length of the circuit and the voltage of the station battery, the supply current of the microphone can vary with the limits of 54.7 to 12.2 milliamperes. In order to make it possible to use one type of microphone caps with such a big range of current variation, resistances of 300 and 560 ohm are connected in the set circuit, being switched on and off by means of a bridge. By means of these resistances it is possible to limit the supply current of the microphone within the limits of 12 to 32 milliamperes.

The inclusion of the indicated resistances shunted with the by-pass condenser of 1.2 microfarad capacity, increases to a certain extent the

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attenuation of the local effect during operation of the set on long and short lines. But this condenser is also used as a capacitance in the bell circuit.

The variable resistance of 15,000 ohm, connected in the bell circuit, is designed for regulation of the loudness of the bell sounding.

The set circuit provides for the possibility of connecting 2 sets -- a basic and auxiliary -- in one subscriber's line. Besides: (1) depending on the method of switching the signal, the call enters both sets or the auxiliary set only; (2) when the microtelephone is lifted in the basic set, it goes dead in the auxiliary set; (3) by lifting the microtelephone in the basic set, a conversation being conducted with the auxiliary set can be broken; (4) when a number is dialled on one set the bell circuit of the other set is cut off; (5) during the conversation, continuity of the connection holding the station is secured at the moment of lifting the microtelephone on the other set.

The basic and auxiliary sets have a unified circuit. In case of paired work of the sets, their sockets are connected to each other by a 3-wire line. Shown in Figure 2 is one of the models of the external shape of the new telephone set. The set has a streamlined form, without sharp corners and ribs. The body of the set and its microtelephone are made of plastic. The number selector is sunk in the body of the set, which reduces the possibility of breakage of the dial. The microtelephone is somewhat shortened in comparison to the microtelephones of existing types. Owing to the position of the microphone being changed in the microtelephone with respect to the mouth of the person talking, high efficiency is attained.

The set has a block design and is assembled from 7 separate finished units, which have been adjusted in the process of production. The following units make up the set: (a) base, (b) circuit block, (c) bell, (d) number selector, (e) body, (f) microtelephone, and (g) plug socket with cord.

The base of the set is steel, stamped with rubber rest legs. To it is attached the bell with loudness regulator and circuit block. In the front part of the inside of the base is placed the set circuit. The base is attached to the body of the set by means of lock screws.

The circuit block of the set is a metal box with a plastic top. On the top of the block are put terminals with screws for connecting the conductors of the cords running from the microtelephone, socket, number dial, and bell, and in case of need also from push buttons. On the same top are fastened the contact springs of a lever switch. Together with them by means of special springs the key of the lever switch is mounted, which makes it possible to adjust and check contacts before assembly of the set.

The lobes of the contact springs pass through the top of the block; during the mounting of the block the leads of units that enter into the set's circuit are welded to them. Flanges are provided in the plastic top of the block, being used in the capacity of rests for the contact springs; correctness of the springs' position is thereby secured and the process of their adjustment shortened.

In the box of the circuit block are accommodated all elements of the talking line, their leads being connected to the terminals of the top by means of electrowelding. After assembly and checking, the box of the block is filled with insulating material for protection of the units placed in it from moisture, corrosion, and mechanical damage. The filled

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box is covered with the top and fixed by screws to the base of the set.

Such a design of the block excludes the need of using a circuit rope in the set, permits using capacitors without boxes and frameless transformer and secures good composition of the circuit elements with minimal dimensions of the set body. In case of damage inside the block, the inspector, using a screw driver, can replace this block with a spare one and put it in the workshop for repair.

The set's bell is made as a separate unit, which after adjustment and checking is installed at the base of the set. It is equipped with flexible leads having cable shoes for connection to the terminals of the circuit block.

The number selector of the new set is a substantial improvement over the existing model, its least reliable parts having been strengthened. In particular, the length of the worm axis thread and the height of the weight holder have been increased, which prevents the latter from turning. Moreover, the area of the cross section of the speed control spring has been increased, since in the process of testing, breakage of this spring occurred at the spot of its bracing. In order to reduce the wear of the worm axis and the bearings, ball supports are used in both bearings. In making the pins of the number selector, "tekstolit" was used instead of fibre; thereby the wear resistance of the pins was increased and constancy of the impulse ratio secured in case of humidity variation The guide is cast (under pressure); this results in a better fit to leading parts and lowered wear. The diameter of the pawl shaft was also enlarged, with the result that the possibility is exclused of breakage of the shaft in process of operation. For technological considerations, the thickness of the bottom of the speed control drum was increased and the guide and cam of the large pinion are made of "voloknit." Proceeding from the same considerations, the question is being examined of replacing the stamped speed control holder by one cast under pressure. All these measures will heighten the stability of the operation of the number selector bringing its service period up to 500,000 complete turns of the dial.

In order to prevent continuous ringing in those cases when the microtelephone is not properly put in its place, and also with the object of eleiminating bending and jamming of ring-off buttons, the latter have enlarged head parts sliding in the guides. The general composition of the set units is shown in Figure 3.

The testing of the model of the talking line circuit showed that in case of balancing that secures attenuation of the local effect in the whole range of frequencies of not lower than 3.5 nep, the syllable articulation of the new telephone set amounts to 80% and more. It was in the process of testing established that the indicated degree of balancing in the given scatter of line parameters cannot be obtained by means of 4-link balance circuits, composed of elements with linear characteristics. It is therefore necessary to work out and apply nonlinear resistances.

It is also expedient to reject the use of highly sensitive carbon microphones. Instead of the latter it would be desirable to use a simple stable noncarbon microphone, which has small output and good characteristics, in combination with an amplifier on crystal diodes or triodes which will provide the necessary level of transmission. A similar combination can prove useful also in developing the circuit of the set's receiving part. These problems are at present being solved side by side with the problem of improving the [illegible] of regulating the loudness of the ring sounding.

It is essential that the cable industry organize in the shortest time the production of durable telephone cords with high insulating properties, for damage to cords is the most frequent cause of telephone failures. In the new set this shortcoming must be corrected.

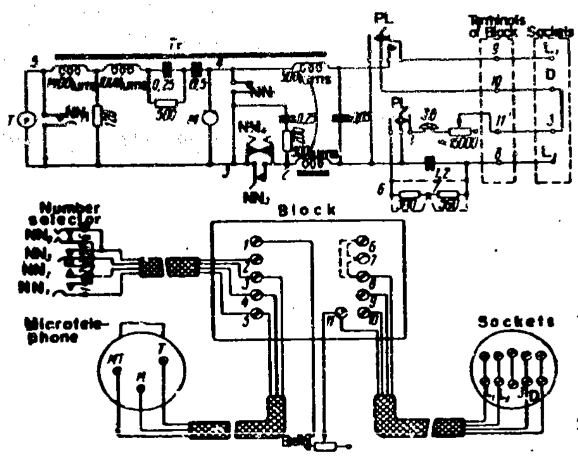

Figure 1

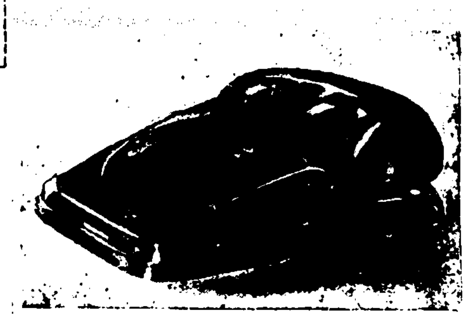

Figure. 2

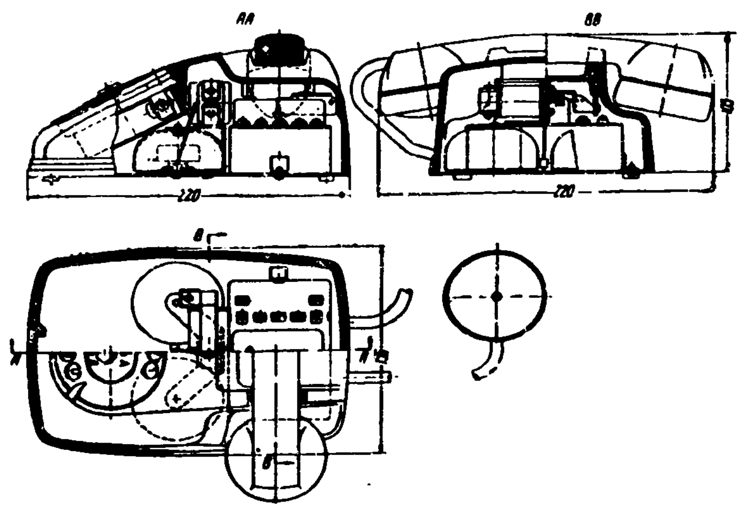

Figure. 3

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SECTIONS IN FREQUENCY-SHIFT KEYING

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With introduction into radio communications of technical means that possess increased resistance to interference (frequency telegraph, 2-channel frequency telegraph), use was begun of more perfected terminal telegraph equipment that operated at high speeds of keying (200 bauds and more). In this connection arose the requirements that were levelled on transmitting and receiving radio centers. In particular, the standards in the temporary acting forces of the signal introduced by radio devices became more rigid.

Considering that not all radio centers have equipment for measuring acting forces, I proposed a simple method of determining the acting forces introduced in the telegraph signal by the transmitting or the receiving line, by means of simple measurements made at the output of the receiving device with the aid of an oscillograph.

The method is based on the following generally known phenomena. If the frequency of the first heterodyne is varied from $f_g = f_c - f_{np}$ to $f_g = f_c + f_{np}$ [g = heterodyne; np = acting force] or the frequency of the second heterodyne is varied from $f_{2g} = f_{np} - F$ to $f_{2g} = f_{np} + F$, then in the receiving stand (PChM) or any other that operates on low frequency) signals of pressing are at places exchanged with signals of detaching (i.e., the frequency of the signals of pressing becomes equal to the frequency of signals of detaching, and conversely) and reverse operation will occur at the output of the receiving stand.

It is quite evident that if the receiving stand introduces the acting force, then the sign of this acting force will not change with variation of the tuning of the first or second heterodyne; but if the transmitter introduces the acting force, then the sign of the acting force is changed to the reverse.

It is not hard to show that if the acting force in the first instance ($f_g = f_c - f_{np}$ or $f_{2g} = f_{np} - F$) is equal to m, and in the second instance ($f_g = f_c + f_{np}$ or $f_{2g} = f_{np} + F$) is equal to n, then the acting force introduced by the receiving device, is determined by the formula:

$$P_1 = \frac{m + n}{2}, \qquad (1)$$

and the acting force, introduced by the transmitter, is determined by the formula

$$P_2 = \frac{m - n}{2}. \qquad (2)$$

In fact, if the acting force introduced by the receiving device is equal to P_1, and that introduced by the transmitter is P_2, then it is evident that in the first tuning of the heterodyne the total acting force at the output of the receiving stand will be equal to $m = P_1 + P_2$, and in the second tuning of the heterodyne it will be equal to $n = P_1 - P_2$, from which also follows formulae (1) and (2).

Presented below is a table of the most typical cases during observation of signals at the output of the receiving stand of frequency modulation, with use of which it is easy to determine the magnitude, character and place of origin of the acting force.

Character and Magnitude of Acting Force at Output of Receiving Device		Character and Magnitude of the Acting Force Introduced by Receiving Device	Character and Magnitude of the Acting Force Introduced by the Transmitting line	Remarks
With $f_g = f_c - f_{np}$	With $f_g = f_c + f_{np}$			
0	0	0	0	Transmitting line and receiving device do not introduce the acting force
$+P_1$,%	$+P_1$,%	$+P_1$,%	0	Receiving device introduces a plus acting force
$-P_1$,%	$-P_1$,%	$-P_1$,%	0	Receiving device introduces a minus acting force
$+P_2$,%	$-P_2$,%	0	$+P_2$,%	Transmitting line introduces a plus acting force
$-P_2$,%	$+P_2$,%	0	$-P_2$,%	Transmitting line introduces a minus acting force
m	n	$P_1 = \frac{m+n}{2}$	$P_2 = \frac{m-n}{2}$	Sign and value of P_1 and P_2 depend on the sign and value of m and n

If the acting force bears a variable character, then the given method is not applicable. In using the method described, it is essential to bear in mind that variation of the frequency of the first or second heterodynes (from minus to plus) to 2 f_{np} or 2F is not equivalent; in the first case the value P_1 will take into account the acting force introduced by the received (amplifiers of intermediate and low frequencies) and the receiving stand of frequency modulation; in the second case the acting force introduced by the amplifiers of the intermediate frequency of the receiver, will be carried to the transmitting line, i.e., will enter into P_2.

It follows from formulas (1) and (2) that the described method of control of the work of the transmitters (in PTRK, at a receiving center, etc) excludes the possibility of errors being introduced by the receiving device during measurement of the transmitter's acting force.

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